



UNITED STATES DEPARTMENT OF COMMERCE  
U.S. Census Bureau  
Washington, DC 20233-0001

May 19, 2022

DSSD 2020 POST-ENUMERATION SURVEY MEMORANDUM SERIES #2020-J-04

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Subject: 2020 Post-Enumeration Survey Estimation Methods:  
Characteristic Editing and Imputation

This report is part of a series describing the methodology and results of the 2020 Post-Enumeration Survey (PES) estimation activities. Specifically, this report summarizes the 2020 PES editing and imputation methods to fill in missing and resolve inconsistently reported demographic characteristics. The characteristics are relationship, age, sex, race, Hispanic origin, and tenure.

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# United States Census 2020

## **2020 Post-Enumeration Survey Estimation Methods: Characteristic Editing and Imputation**

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## Executive Summary

In this memorandum, characteristic imputation refers to filling in missing values of relationship, race, Hispanic origin, age, sex, and tenure for person and housing unit records in the Post-Enumeration Survey (PES). The PES used the same characteristic edit and imputation system used by the 2020 Census. There were three aspects of the characteristic edit and imputation process.

- **Editing characteristics.** The census characteristic edit and imputation system included many rules for editing the input data. The purpose of editing was to achieve consistency of the reported characteristics for each person and household. The extent of editing in the PES ranged from 0.2 percent of PES records for sex to 1.5 percent for relationship. Refer to Ramirez and Borman (2021) for more information about editing in the 2020 Census.
- **Coding Race and Hispanic Origin.** The PES assigned codes to detailed origin<sup>1</sup> responses for race and Hispanic origin. There were 65.1 percent and 4.4 percent of PES records with a detailed origin response for race and Hispanic origin, respectively. Race composition changed for 9.9 percent and Hispanic origin 0.6 percent of PES records because of the detailed origin responses. The changes in race composition were largely because of another race being added as a result of the detailed origin response, such as from White alone to White and another race. The percentage of detailed origin responses for race was higher in the PES than in the 2010 Census Coverage Measurement (CCM) program because the PES allowed detailed origin responses for two more race categories: White and Black or African American.
- **Imputing Characteristics.** The highest rate of imputation in the P sample was 11.4 percent for age, and the lowest was 1.7 percent for sex. 15.7 percent of P-sample records had at least one characteristic imputed. The percentage of cases with characteristics imputed in the PES was higher for all categories as compared to the 2010 CCM program.

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<sup>1</sup> Respondents were asked to provide detailed origins for the race and Hispanic origin categories they selected, but this was not a requirement.

# 1. Introduction

This document summarizes the characteristic edit and imputation methods used in the 2020 Post-Enumeration Survey (PES).<sup>2</sup> In addition, it compares the results of characteristic edit and imputation from the PES with those from the 2010 Census Coverage Measurement (CCM) program.

Characteristic editing and imputation is the process by which certain missing or inconsistent household or person information is filled in or resolved for the census or the PES. The characteristics that are subject to editing and imputation in the PES are:

- Relationship to householder
- Age
- Sex
- Race
- Hispanic origin
- Housing unit tenure (owned or rented)

The first five of those characteristics are person characteristics and can vary across different people in a housing unit, while tenure is a housing-unit characteristic and is the same for everyone in a housing unit. The PES consisted of the Population (P) sample and the Enumeration (E) sample. The P sample was derived from a listing of housing units and people in the United States and Puerto Rico that was independent of the 2020 Census. People living in group quarters (e.g., a prison, college dormitory, or nursing home) were not eligible to be in the P sample. The E sample consisted of a separate sample taken from census records in the same blocks from which the P sample was drawn. Like the P sample, people in group quarters were not included in the E sample. For more information on the design of the PES, refer to Kennel (2019).

For the P sample, the PES used the same characteristic edit and imputation system that was used for the 2020 Census with minor changes as discussed in section 2. The 2010 CCM program also used the same characteristic edit and imputation system that was used for the 2010 Census. Since the E sample is a sample of census enumerations, we used the edited and imputed values as they were assigned in the census. The same approach was taken in 2010.

During the PES Interview, we collected information about a household on both Census Day (April 1, 2020) and PES Interview Day (several months later). This allowed us to perform characteristic editing and imputation for both the Census Day and Interview Day households. Section 2 provides the details on the process of editing and imputation for the two households.

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<sup>2</sup> The Census Bureau's Disclosure Review Board has reviewed this product for unauthorized disclosure of confidential information and has approved the disclosure avoidance practices applied to this release. CBDRB-FY22-216.

An important feature of the census characteristic edit and imputation system was editing the reported values to achieve compatibility of characteristics among household members. The PES used census editing procedures to identify implausible characteristic values, such as a 10-year-old being a parent of another household member.

The census characteristic edit and imputation system also had other features that have been part of missing data procedures since 2010. One example was the use of first name and last name to aid in the imputation of sex and Hispanic origin, respectively. Another was checking detailed origin responses to help identify race and Hispanic origin. This included autocoding (a computer matching procedure) and residual coding (a clerical procedure).

Section 2 of this document summarizes the important steps to prepare the data for coding, editing, and imputation. It also provides an overview of certain features of the census characteristic edit and imputation system. Section 3 provides results of characteristic editing and imputation for the PES. For the sake of comparison, the tables in section 3 include results from the 2010 CCM program when applicable.

## 2. Methods

### 2.1. Different Census Day and Interview Day Households

In the PES, it was possible to collect information for two different households at the same housing unit. The two possible households were the Census Day (April 1, 2020) household and the PES Interview Day household. Because the PES interview occurred several months after Census Day, there may have been different people residing at an address at these two time points. This had direct implications on the characteristic edit and imputation system because the census editing rules assumed one household per housing unit.

We did not want the characteristics of people in one household to be influenced by the characteristics of people in the housing unit at a different time. To deal with this situation, when the household composition differed between Census Day and Interview Day, we generally split the PES roster into what existed on Census Day and on Interview Day and imputed characteristics for each household separately. People who were recorded at the housing unit on both days were placed in both households so that the characteristic edit and imputation system was provided an accurate representation of the household composition at each time point. However, these duplicated records were only used once for the remaining PES estimation procedures, using the characteristics of the Census Day record.

## 2.2. Imputation of Household Size for Noninterviewed Housing Units

There were instances where an interview with an occupied housing unit could not be conducted (e.g., refusal, no contact made), and therefore no response record was created. For person estimation, these housing units were handled by a noninterview adjustment (Beaghen et al., 2022). For housing unit estimation, since these housing units were occupied, we needed to impute tenure and race and Hispanic origin of the householder. To do this, we created dummy person records to allow us to run them through the census edit and imputation system and obtain these characteristics.

## 2.3. Additional Information on Characteristic Editing and Imputation

### 2.3.1. Coding Race and Hispanic Origin Detailed Origin Data

We did additional processing to take advantage of the race and Hispanic origin detailed origin responses in the PES response data. In this procedure, also known as autocoding, detailed origin responses were computer matched to a database with codes for many detailed origin characteristics. If the system made a match, then it assigned a numeric code to the response. Some detailed origin responses could not be autocoded and were sent to the National Processing Center for residual coding, a clerical procedure. After the autocoding and residual coding procedures were complete, we were able to use the detailed origin responses to assign race and Hispanic origin as appropriate.

### 2.3.2. Imputation of Sex and Hispanic Origin

The census characteristic edit and imputation system used look-up tables of names for imputation of sex and Hispanic origin from the input data files. A look-up table consisting of first names and reported sex tallies was used for the imputation of sex. Another look-up table was used for the imputation of Hispanic origin and consisted of last names for householders and Hispanic origin tallies before editing. For the PES, a combined look-up table for the United States and Puerto Rico was created from the PES data to assist in the characteristic edit and imputation process.

### 2.3.3. Matching to Previous Census Results and Administrative Records

The census characteristic edit and imputation system checked whether any characteristic imputation could be done by matching the person to a previous census response or administrative record. If a match was made, then the characteristic was assigned the same value as that of the matched case. This imputation was done prior to the neighborhood imputation that used hot decks. To maintain independence from the 2020 Census, the PES did not include address information in this matching. As a result, fewer matches were made and



the use of administrative records for characteristic imputation was much lower than in the 2020 Census.

## 2.4. Limitations

The 2010 CCM program allowed respondents to provide detailed origin responses for only four race groups: American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, and Some Other Race. The 2020 PES allowed detailed origin responses for all six race groups, which includes White and Black or African American. Because of these differences, caution should be used while comparing certain characteristic editing and imputation results across years.

## 3. Results

The universe for these results is the set of P-sample people that contributed to dual-system estimation. This universe includes people with an unresolved inclusion status for which we imputed an inclusion probability. In addition to omitting people who were rostered during the interview but were later determined to be out-of-scope, this universe also omits person records in households for which the interview was determined to be insufficient for survey processing. Such households were treated as noninterviews (Beaghen et al., 2022). This universe differs from the 2010 CCM results in Shores et al. (2012), which used all records on the P-sample file and thus included out-of-scope people and people in insufficient interview households. We recalculated the 2010 results using the same universe definition as 2020. The tables that follow reflect this change.

Table 1 summarizes the impact of editing demographic characteristics of P-sample people. For relationship, age, and sex, it shows the number of cases for which reported values were changed because of the census characteristic edit and imputation system and the percentage of the total number of records in the P sample that were changed through editing. For this table, the number of records changed for a characteristic represents the number of times that a respondent-provided characteristic was changed or edited by the census editing rules. The number of records changed through the census editing procedures was small relative to the total for all the characteristics. There were no changes in reported tenure values. Changes to reported race and Hispanic origin values were as a result of detailed origin responses and are discussed later.

Note that it is possible that the respondent-provided characteristics could be edited during the PES person clerical matching operations, prior to the PES data being sent through the census characteristic edit and imputation system. These types of edits are also not counted as changes because of the editing process. The 2020 percentages are based on the count of 284,000 records in the P sample as defined previously. All record and imputation counts cited in this memo are unweighted.

Table 1. P-sample Person Records Changed by Edits

Year	Characteristic	Count <sup>1</sup>	Percent of P sample <sup>2</sup>
2020	Relationship	4,400	1.5
	Age	1,800	0.6
	Sex	550	0.2
2010	Relationship	4,600	1.3
	Age	1,700	0.5
	Sex	90	0.0

<sup>1</sup> We considered a record as “changed” if it had a non-missing entry in the P-sample file and did not match the final edited entry after the characteristic edit and imputation process.

<sup>2</sup> The 2020 percentages are based on the count of 284,000 records in the P sample.

Source: U.S. Census Bureau, Decennial Statistical Studies Division, 2020 Post-Enumeration Survey (May 2022 Release) and 2010 Census Coverage Measurement Survey

The PES allowed people to provide a detailed origin race responses for each of the six race groups: American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White, and Some Other Race. If a person selected one of these races in the interview, then the person had the option of providing a detailed response for that race category. For all categories, the effect was to sometimes change the person’s race composition by adding additional races. For example, there were cases for which someone selected Asian as the race and then provided “Persian” for the Asian race detailed origin. The detailed origin changed the person’s race composition from Asian to Asian and White. For Some Other Race, the detailed origin response could add a race (as in the previous example) or change the Some Other Race response to be one of the five specific race groups. An example of the latter situation is someone who selected Some Other Race and provided “Native American” as the detailed origin. The race for this person was changed from Some Other Race to American Indian or Alaska Native.

Table 2 presents the number of detailed origin responses for race and Hispanic origin. Unlike the 2010 survey, the 2020 PES allowed detailed origin responses for White and Black or African American, and this explains the increase in total race detailed origin responses from 2010.

Table 2. Number of Detailed Origin Responses for the P sample

Year	Characteristic	Count	Percent of P sample
2020	Hispanic Origin	12,500	4.4
	Race	185,000	65.1
2010	Hispanic Origin	14,500	4.1
	Race	50,500	14.2

Source: U.S. Census Bureau, Decennial Statistical Studies Division, 2020 Post-Enumeration Survey (May 2022 Release) and 2010 Census Coverage Measurement Survey.

Table 3 shows the number of people that specified each race alone or in combination and the percent for which a detailed origin response was provided along with that race. Note that a person can be included in multiple rows. Overall, most people chose to provide a detailed origin

response to elaborate on their race. The rates of detailed origin responses for Asian and Native Hawaiian or Other Pacific Islander are lower than other races because, like the 2020 Census<sup>3</sup>, the PES race question included specific response options for some detailed origins within these races (e.g., Japanese for Asian and Samoan for Native Hawaiian or Other Pacific Islander). This likely captured some of the detailed origins that people otherwise would have provided.

Table 3. Reported Race and Rates of Detailed Response in the 2020 and 2010 P Samples

Year	Reported Race Alone or in Combination	Count	Percent with a Detailed Origin Response
2020	White	190,000	69.5
	Black or African American	32,500	81.5
	American Indian or Alaska Native	11,500	91.3
	Asian	18,500	15.1
	Native Hawaiian or Other Pacific Islander	2,500	28.0
	Some Other Race	18,000	86.1
2010 <sup>1</sup>	American Indian or Alaska Native	18,500	94.6
	Asian	21,500	11.2
	Native Hawaiian or Other Pacific Islander	3,700	24.3
	Some Other Race	31,000	95.2

<sup>1</sup> The 2010 CCM did not allow detailed origin responses for the White and Black or African American race groups. Source: U.S. Census Bureau, Decennial Statistical Studies Division, 2020 Post-Enumeration Survey (May 2022 Release) and 2010 Census Coverage Measurement Survey.

To examine the extent of changes for the individual race detailed origin responses, we reviewed records for which there was only a single detailed origin response. By so doing, we could be sure that any observed changes to race occurred because of the entry in that specific race's detailed origin response. Table 4 presents results for these outcomes.

Table 4 shows that of the total cases with a single detailed-origin response, 15 percent had a change to the race composition because of that response. Native Hawaiian or Other Pacific Islander has the highest rate of changes (41.7 percent), though this group is a small portion of the total P sample. The detailed origin responses for American Indian or Alaska Native, Asian, and Black or African American resulted in a relatively few changes.

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<sup>3</sup> A sample copy of the 2020 Census housing unit paper questionnaire is available at <https://www2.census.gov/programs-surveys/decennial/2020/technical-documentation/questionnaires-and-instructions/questionnaires/2020-informational-questionnaire.pdf>.

Table 4. Records with Only One Race Detailed Origin Response

Year	Race	Records with One Race Detailed Origin Response		Records Changed as a Result of a Detailed Origin Response	
		Count	Percent of P sample	Count	Percent of Detailed Origin Responses
2020	White	129,000	45.4	23,000	17.8
	Black or African American	25,500	9.0	1,000	3.9
	American Indian or Alaska Native	9,300	3.3	250	2.7
	Asian	2,600	0.9	150	5.8
	Native Hawaiian or Other Pacific Islander	600	0.2	250	41.7
	Some Other Race	15,000	5.3	2,600	17.3
	Total	183,000	64.4	27,500	15.0
2010 <sup>1</sup>	American Indian or Alaska Native	17,500	4.9	100	0.6
	Asian	2,400	0.7	300	12.5
	Native Hawaiian or Other Pacific Islander	850	0.2	250	29.4
	Some Other Race	29,500	8.3	5,600	19.0
	Total	50,000	14.0	6,300	12.6

<sup>1</sup> The 2010 CCM did not allow detailed origin responses for the White and Black or African American race groups

Note: Counts may not sum to totals shown because of rounding.

Source: U.S. Census Bureau, Decennial Statistical Studies Division, 2020 Post-Enumeration Survey (May 2022 Release) and 2010 Census Coverage Measurement Survey.

Table 5 shows the count of each race alone or in combination at various stages of the characteristic edit and imputation process. It documents the size of each race group after the reported count, after coding of detailed origin responses, and after imputation. Note that a person can be included in multiple rows.

As mentioned previously, when a person provided a detailed origin response for any of the six race groups, the result might be to add a different race group, including Some Other Race, to the person's race composition. For Some Other Race, the detailed origin response could also change that reported race to be one of the five specific race groups. For 2020, the Some Other Race count had a net increase from 18,000 reported cases to 38,000 cases after coding of the detailed origin responses. Much of this net increase was from people who provided a detailed origin response for White, and that detailed origin response was used to add Some Other Race to the race composition. Because the 2010 CCM did not allow detailed origin responses for the White and Black or African American race groups, there were fewer cases for which Some Other Race was added to a person's race composition. As a result, in 2010 there was a net decrease of about 5,000 people in the Some Other Race group after the coding of detailed origin responses. This net decrease was because of detailed origin responses for Some Other Race that were used to change the reported race to be one of the five specific race groups.

Table 5. Reported Race for the P Sample at Stages of the Characteristic Edit and Imputation Process

Year	Race	Reported Count	Count after Coding Detailed Origins	Count after Imputation
2020	White	190,000	192,000	201,000
	Black or African American	32,500	33,500	35,000
	American Indian or Alaska Native	11,500	13,500	13,500
	Asian	18,500	20,000	21,000
	Native Hawaiian or Other Pacific Islander	2,500	2,600	2,900
	Some Other Race	18,000	38,000	44,000
2010	White	244,000	248,000	252,000
	Black or African American	40,000	41,000	42,000
	American Indian or Alaska Native	18,500	19,500	19,500
	Asian	21,500	23,000	23,000
	Native Hawaiian or Other Pacific Islander	3,700	3,900	4,000
	Some Other Race	31,000	26,000	26,500

Note: Counts may appear the same at subsequent stages because of rounding. A person can be included in multiple rows.

Source: U.S. Census Bureau, Decennial Statistical Studies Division, 2020 Post-Enumeration Survey (May 2022 Release).

Table 6 presents the proportion of records that were altered in 2020 only. The results from 2010 are not presented because they are not directly comparable. The 2010 results only considered detailed origin response changes from Hispanic to non-Hispanic and did not allow detailed origin responses for all race categories. In 2020, there were 1,700 people, 0.6 percent of the P sample, whose Hispanic origin changed because of a detailed origin response. The edits changed about 650 records from Hispanic to non-Hispanic and 1,100 records from non-Hispanic to Hispanic. The former case occurred because of the detailed origin response for Hispanic origin (e.g., “Brazilian”), while the latter occurred because of a detailed origin response for race (e.g., “Mexican American” for the White detailed origin). There were 28,000 records, 9.9 percent of the P sample, for which race changed because of valid detailed origin responses. For both race and Hispanic origin, we excluded from our analyses unusable detailed origin responses such as those consisting of only numbers.

This table differs from Table 4, in which we counted only records with one race detailed origin response. Since the results in Table 6 include records with multiple detailed origin responses, the total in Table 4 is less than the number given in the race row in Table 6.

Table 6. Changes Because of Detailed Origin Responses for the P sample

Characteristic	Count	Percent of P sample
Hispanic Origin	1,700	0.6
Hispanic to Non-Hispanic	650	0.2
Non-Hispanic to Hispanic	1,100	0.4
Race	28,000	9.9

Note: Counts may not sum to totals shown because of rounding.

Source: U.S. Census Bureau, Decennial Statistical Studies Division, 2020 Post-Enumeration Survey (May 2022 Release).

Table 7 shows for each characteristic the percentage of people in the P and E samples who had that characteristic imputed, as well as the percentage that had at least one of the characteristics imputed. For this memorandum, we considered a characteristic as imputed if that characteristic was not reported. Characteristics that changed because of edits or detailed origin values are not considered imputations. This differs from Shores et al. (2012), in which edits and changes because of detailed origin responses were included as imputations. We recalculated the 2010 results to reflect this change. The entries in Table 7 are unweighted.

In the P sample, the percentages of people requiring imputation were higher for all characteristics in 2020 than in 2010. The largest absolute differences were for age and race. The percentage of people in the P sample with at least one characteristic imputed was also higher in 2020 than in 2010. The higher amount of missing characteristic data in the P sample made matching more difficult and may have added variability to the PES estimates.

In the E sample, the percentages requiring imputation were higher in 2020 than in 2010 for all characteristics, as was the percentage with at least one characteristic imputed. This result for the 2020 Census was noted by Bentley and Konya (2021). Note that for all characteristics except age in 2020, the table shows a higher imputation rate for the E sample than the P sample. Recall that our universe for the P sample omits certain records, including person records in households with insufficient information for survey processing. Marra and Kennel (2022) note that the 2020 PES had a higher rate of such interviews. For the E sample, in many cases the analogous census households are included in the universe because these records contributed to the estimation of the correct enumeration rate for dual-system estimation. Compared to 2010, the 2020 E sample had relatively more people with multiple characteristics imputed and less people with only one characteristic imputed.

Table 7. Imputation Rates in the 2020 and 2010 P and E Samples

Sample	Year	Total People	Percentage of people with imputed characteristic						Percent with at least one imputed characteristic
			Relationship	Age	Sex	Race	Hispanic Origin	Tenure	
P sample	2020 <sup>1</sup>	284,000	1.9	11.4	1.7	5.8	3.7	3.7	15.7
	2010	356,000	0.9	4.5	0.9	1.9	1.6	2.0	6.6
E sample	2020	397,000	3.8	8.3	3.0	11.1	9.1	6.2	16.8
	2010	384,000	1.4	4.9	1.5	5.3	5.1	3.3	15.0

1. For a discussion of the size of the 2020 P sample, refer to the text.

Source: U.S. Census Bureau, Decennial Statistical Studies Division, 2020 Post-Enumeration Survey (March 2022 Release) and 2010 Census Coverage Measurement Survey.

Table 7 shows that the 2020 P sample contained more than 100,000 fewer people than the 2020 E Sample. There are several reasons for this difference. First, the P sample had more noninterviews than the E sample. In particular, the 2020 P sample had many households for which the interview was determined to be insufficient for survey processing (Marra and Kennel, 2022). As mentioned previously, these households were treated as noninterviews for the P sample and were not included in our analysis. Secondly, there were some differences in the sampling methodology and outcomes that resulted in fewer P-sample housing units than E-sample housing units. Finally, some of the difference is related to who is in scope for each sample. The P sample does not include erroneous enumerations, such as duplicates and people who were determined to not be living at the sample address. However, the E sample does include erroneous enumerations because that is what the E sample is designed to measure.

## 4. Conclusion

Overall, the 2020 P Sample had higher rates of item missingness than in 2010. This higher rate may have caused challenges in matching P-sample people to the census. For example, someone for whom we did not record age or date of birth would have been harder to match. Another issue was the characteristic edit and imputation process may have assigned demographic values different from a person's true values, which impacts the coverage estimation for the demographic groups. For example, an imputed child in the P sample would contribute to the estimation of the match rate for children, but this person may actually have been an adult who did not report age or relationship. Despite this issue, the characteristic edit and imputation process used well-established methods for imputing the missing values and likely mitigated the impact of nonresponse bias.

## 5. References

Beaghen, M., R. Turner, and M. Jost, “2020 Post-Enumeration Survey Estimation Methods: Missing Data for Person Estimates,” DSSD 2020 Post-Enumeration Survey Memorandum Series #2020-J-05, U.S. Census Bureau, 2022.

Bentley, M., and S. Konya, “2020 Census Operational Quality Metrics: Item Nonresponse Rates,” 2021, <[www.census.gov/newsroom/blogs/random-samplings/2021/08/2020-census-operational-quality-metrics-item-nonresponse-rates.html](http://www.census.gov/newsroom/blogs/random-samplings/2021/08/2020-census-operational-quality-metrics-item-nonresponse-rates.html)>.

Kennel, T., “The Design of the Post-Enumeration Survey for the 2020 Census,” DSSD 2020 Post-Enumeration Survey Memorandum Series #2020-B-01, U.S. Census Bureau, 2019.

Marra, E., and T. Kennel, “Source and Accuracy of the 2020 Post-Enumeration Survey Person Estimates,” DSSD 2020 Post-Enumeration Survey Memorandum Series #J-01, U.S. Census Bureau, 2022.

Ramirez, R., and C. Borman, “How We Complete the Census When Demographic and Housing Characteristics Are Missing,” 2021, <[www.census.gov/newsroom/blogs/random-samplings/2021/08/census-when-demographic-and-housing-characteristics-are-missing.html](http://www.census.gov/newsroom/blogs/random-samplings/2021/08/census-when-demographic-and-housing-characteristics-are-missing.html)>.

Shores, R., J. Mulligan, and R. Sands, “2010 Census Coverage Measurement Estimation Report: Characteristic Imputation Results,” DSSD 2010 Census Coverage Measurement Memorandum Series #2010-G-07, U.S. Census Bureau, 2012.

U.S. Census Bureau, “2020 Census Operational Quality Metrics: Release 1,” 2021, <[https://www2.census.gov/programs-surveys/decennial/2020/data/operational-quality-metrics/census-operational-quality-metrics-release\\_1.xlsx](https://www2.census.gov/programs-surveys/decennial/2020/data/operational-quality-metrics/census-operational-quality-metrics-release_1.xlsx)>.